STUDY OF POTENTIAL PALM ACID OIL (PAO) FROM SLUDGE PALM OIL MILL EFFLUENT (POME) AS GOAT'S FEED

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Kajian ini dirancang untuk menentukan formulasi asas makanan haiwan untuk kambing dari sisa pepejal yang berbeza dan untuk menyiasat keberkesanan formulasi sisa pepejal yang berbeza melalui pertumbuhan kambing. PAO, rumput napier, sisa kelapa dan salad air dijadikan sebagai sampel untuk menghasilkan makanan haiwan untuk kambing. POME dihasilkan semasa proses kilang minyak kelapa sawit. PAO dihasilkan semasa proses pengeluaran POME. Sisa pepejal yang dihasilkan telah menyebabkan masalah pencemaran kepada alam sekitar. Sisa pepejal menjalani kaedah pengkomposan untuk menghasilkan makanan haiwan yang berguna untuk pertumbuhan kambing. Kesemua sampel ini dikumpulkan dan dicampur dengan mengikuti buku panduan yang bertajuk nutrien bahan makanan Malaysia dan panduan untuk memberi makan lembu dan kambing oleh jabatan perkhidmatan veterinar kementerian pertanian dan industri berasaskan pertanian Malaysia. Empat kambing jantan berusia 6 bulan ke atas digunakan untuk menjalankan eksperimen ini. Purata berat kambing adalah 23-27 Kg. Kemudian, kambing diberi makan untuk menganalisis parameter. 3 parameter dianalisis iaitu prestasi pertumbuhan kambing, keperluan nutrien oleh kambing dan berat badan kambing. 4 Kambing diberi makan campuran makanan yang berbeza selama 120 hari (14 hari penyesuaian dan 106 hari penilaian). Dalam kajian ini, 4 formulasi telah digunakan sebagai (FA, FB, FC, FD). Setiap formulasi mengandungi nutrien dan komposisi yang berbeza. Semua sampel ini mempunyai nutrien yang diperlukan oleh kambing dan mempunyai potensi yang besar untuk menghasilkan makanan haiwan untuk kambing. Keputusan menunjukkan bahawa kambing yang mengambil formula A mempunyai prestasi pertumbuhan tertinggi dan berat badan.

ABSTRACT

This study was planned to determine the base formulation of animal feed for goat from different solid waste and to investigate the effectiveness of different formulation of solid waste via the growth of goat. PAO, Napier grass, coconut waste and water lettuce were used as the sample to produce animal feed for goats. POME is produced during palm oil mill process. PAO is produced during extracted process of POME. The solid waste produced has caused the pollution problem to the environment. The solid waste undergoes composting method to produce animal feed which is useful to the growth of goat. All these samples were collected and mixed by following the guideline book of title nutrient composition of Malaysian feed materials and guides to feeding of cattle and goats by department of veterinary services ministry of agriculture and agro-based industry Malaysia. The 4 male goats aged 6 months and above were used to conduct this experiment. The average weight of goats was 23-27 Kg. Then, the goats were fed to analyse the parameters. The 3 parameters analysed were growth performance of goats, nutrient requirement by goats and body weight gain (BW). The goats were fed the formulation for continuous 120 days (14 days adaptation and 106 days evaluation). In this study, 4 formulations were used (FA, FB, FC, FD). Each formulation contains different nutrient and composition. All these samples have nutrient needed by the goat and have a big potential to produce the animal feed for goat. Results showed that goat that take formulation A has the highest growth performance and body weight gain (BW).

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LIST OF SYMBOLS

^{o}C	Degree Celsius
Kg	Kilogram
g	Gram
Cm	Centimetre
m	Metre
m^3	Cubic metre
mg	Milligram
L	Litre
ml	Millilitre
%	Percentage
+	Plus sign
[ ]	Brackets
mEq/L	Milliequivalent per litre

LIST OF ABBREVIATIONS

BWG	Body Weight Gain
SWM	Solid Waste Management
MWM	Municipal Waste Management
POME	Palm Oil Mill Effluent
PAO	Palm Acid Oil
N	Nitrogen
P	Phosphorus
K	Potassium
Fe	Iron
Zn	Zinc
Cu	Copper
Na	Sodium
Ca	Calcium
Mg	Magnesium
Al	Aluminium
S	Sulphur
C	Carbon
e.g	Example
etc	And similar other things
et al	And others
BOD	Biochemical oxygen demand
COD	Chemical oxygen demand
FFB	Fresh fruit bunch
DOE	Department of Environment
LA	Local authorities
GHG	Greenhouse gas
FFA	Free fatty acid
RWS	Rumi Watch system
PUFA	Polyunsaturated fatty acid
ADMI	American Dye Manufacturers Institutes
DMI	Dry matter intake
TN	Total nitrogen
CP	Crude Protein
CF	Crude fibre

MPOB	Malaysian Palm Oil Board
CPO	Crude Palm Oil
TS	Total solids
SS	Suspended solids
VS	Volatile solids
CLA	Conjugated linoleic acid
ME	Metabolisable Energy
DM	Dry Matter

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Malaysia is well known for its production and supply of palm oil for global need. Despite the industry's contribution, it is also creating hazards by generating an enormous amount of by-products. On average from about 434 palm oil mills operating throughout Malaysia, about 63 million tonnes of palm oil mill effluent (POME) is generated (Mokhtar et al., 2010). Moreover, it was reported by (Kum and Zahari, 2011) that Malaysia generates an average of 2.2 million tonnes of palm oil mill sludge (POS) annually from the digested POME. The generation of palm oil mill effluent (POME) from the palm oil industry has become a serious issue that not only affects the industry, but also people and the environment. POME is known as a high strength agro-industrial wastewater that contains a large amount of organic matter which eventually increases both the biochemical oxygen demand (BOD) and the chemical oxygen demand (COD) (Bala et al., 2015). The anaerobic digestion applied for the treatment of POME could increase the rate of biodegradation (Poh and Chong, 2009), in addition to the conventional POME treatment using the ponding system. However, if not managed efficiently, the discharge of treated or partially treated POME into a nearby river could lead to severe environmental pollution (Rupani et al., 2010).

With enormous demand from China, European Union, and India, palm oil industry is currently considered the third largest industry that has contribution toward 8.8% of Malaysia's merchandise exports earnings or equivalent to 63.2 billion Malaysia Ringgit (MYR) in year 2013 alone (Malaysian Palm Oil Board, 2016, Kumar, 2014). Malaysia is the second largest producers and exporters of palm oil and palm oil derivatives in the world with the total estimated area of 5.64 million hectare. As the

world second top ranking palm oil producer, an estimated mass of 19.96 million tons of Crude Palm Oil (CPO) was produced from 104.23 million tons of fresh fruit bunches (FFB) by Malaysia in year 2015 (Malaysian Palm Oil Board, 2016).

Palm oil mill effluent (POME) which is a brownish viscous liquid waste becomes the significant concern as it poses a disastrous impact on environment (Wong et al., 2018). Huge amount of degradable organic matter causes POME to have a high biochemical oxygen demand (BOD) chemical oxygen demand (COD) and suspended solids which approximated at 25,000 mg/L, 53,630 mg/L and 19,020 mg/L, respectively. The discharge of untreated POME into steam is prohibited, and additional efficient post treatment process is essential prior to final discharge (Bashir et al., 2017, Lin et al., 2017). POS is highly nutritious and moistures with pH around 8.0 (Rupani et al., 2010). Many works have been reported in upgrading POS to value-added products such as animal feed, free fatty acid extraction, and low-grade soap.

World cities are currently generating over 1.3 billion tons of solid waste per year and the waste generation rates are predicted to be more than doubled over the next twenty years in low and middle income countries (LMICs) (Hoornweg and Bhada-Tata, 2012). In some cases, this waste has been estimated to be as high as 30% of total food waste. It is generally agreed that the most wasted home-produced products are the most perishable, such as bakery and dairy products, fruit and vegetables, and meat and fish (Morgan, 2009).

1.2 Problem Statement

The modern world is confronting several issues such as energy crisis, wastewater generation, air pollution and global warming. However, excessive wastewater generation and depletion of energy are the most important issues for human society (Nayak et al., 2016). The increase in worldwide energy consumption is not sustainable due to population growth and economic development (Schneider et al., 2013). Palm oil mill effluent (POME) is a high strength pollutant with a low pH (due to the organic and free fatty acids), arising from the partial degradation of palm fruits before processing, which has a high biochemical oxygen demand (BOD) and chemical oxygen demand (COD) in the range of 25,000–54,000 mg/L and 50,000–100,000 mg/L, respectively (Iwuagwu and Ugwuanyi, 2014). Several reports have shown that these

values are 100 times higher than those of municipal sewage (Iwuagwu and Ugwuanyi, 2014, Mamimin and Prasertsan, 2011). POME is often discharged directly from a mill, which is objectionable and could pollute streams, rivers, and the surrounding lands (Okwute and Isu, 2007). When POME is discharged into water bodies, it turns the water brown, smelly, and slimy, and causes de-oxygenation (Islam et al., 2017b) that may kill fish and other aquatic organisms (Ezemonye et al., 2008). In addition, environmental pollutants such as heavy metals, high amounts of ammonia, phenolic compounds, large concentrations of organic contentsand low pH severely affect plant seed germination as well as root elongation (Gopalakrishnan et al., 2015).

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Figure 1.1 Discharge of palm oil mill effluent (POME) (image credit: Tan Kian Yong) (2015)

In recent years, the global quest for livestock intensification has been driven rapidly by increasing demand for animal proteins due to a concomitant rise in population, urbanisation and household income (Herrero and Thornton, 2013). The environmental impacts of livestock production are related to emissions of GHG, nitrogen and phosphorus, land degradation, water pollution and insecurity, and biodiversity loss (Steinfeld et al., 2006). one-third of foods produced globally is wasted every year, and this is equivalent to the loss of 1.3 billion metric tons of foods or annual economic depletion of USD 1 trillion (Cheng et al., 2017; Surendra et al., 2016). These humongous amounts of generated solid wastes will certainly degrade the environmental footprint, causing irreversible damage if the implemented countermeasure is unsuccessful. The unpleasant situation is as well further exacerbated by the inevitable solid waste disposals from agricultural and animal farming activities in satiating the increasing

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